



Parallels Optimized Computing

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Agenda

- **Who is Parallels?**
- **Overview of Virtualization Technologies**
- **Parallels Containers Overview**
- **Linux Workload Performance Benchmarks**
- **Summary of Parallels Elastic IT Platform**
- **Parallels Virtual Desktop Infrastructure**
- **Q & A**

Who is Parallels?

- **Founded in 1999**
 - **Over 650 Employees worldwide**
 - **500+ Partners, including Microsoft, Apple, Intel, AMD, Dell, HP & IBM**
-
- Currently, we maintain 85% market share in the Service Provider industry
 - Parallels currently ranks 9th of all organizations globally making contributions to the Linux Kernel

PIXAR
ANIMATION STUDIOS



SOFTLAYER



Parallels Elastic IT for Linux

Parallels is bringing the same platform we developed for the Hosting industry to the Linux Community

- Provides full-featured management tools that are infinitely expandable through a documented Open API (XML-RPC).
- Parallels elastic IT solution enables the creation of an on-demand IT infrastructure within the datacenter to provide on-the-fly resizable compute capacity
- Virtualize high performance Linux workloads including Java, databases and computational tasks that demand near native I/O and network speeds
- Consolidate Linux servers to maximize the utilization of hardware and minimize system administration

Virtualization Technology Comparison

Parallels Containers

Native Performance Architecture

Native Optimizations

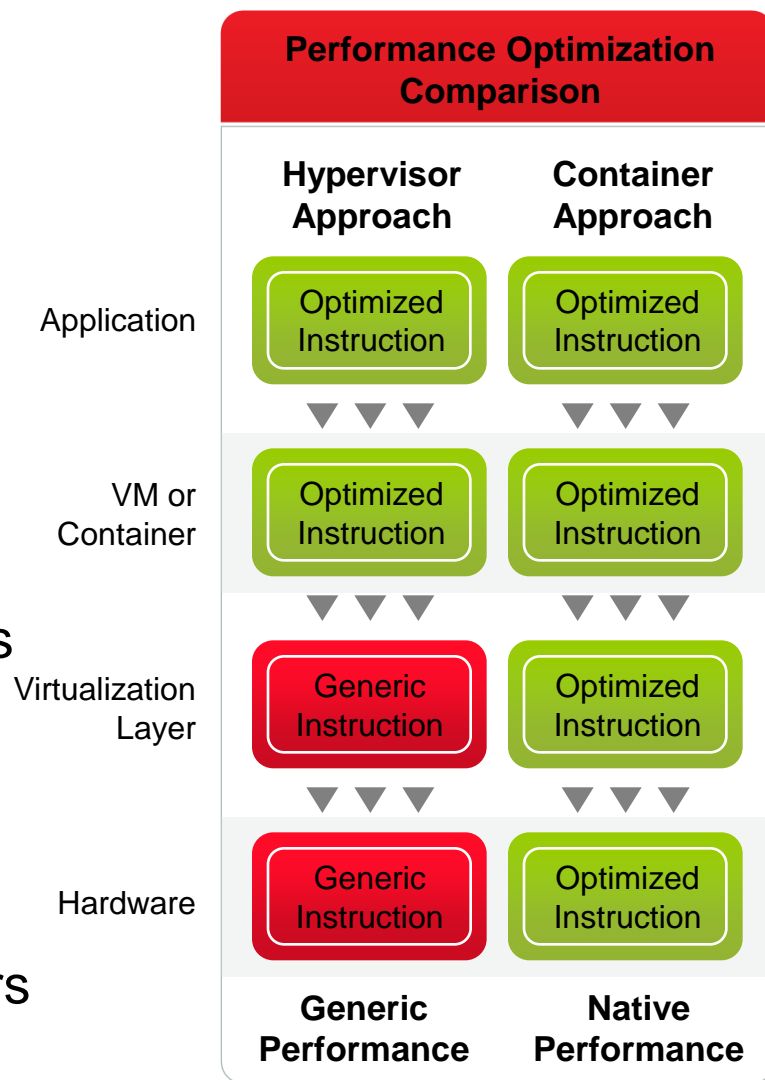
- Maintains all environment optimizations
- Maintains native time clock

Minimal Overhead

- Faster context switching than hypervisors
- Better memory utilization

Suitable for performance spikes

- Scales to the full resources of the server
- Easy to migrate instances to other servers



Parallels Containers: Key Benefits



High Density Consolidation

Maximize server utilization with **negligible overhead**

Dynamic Resource Control
Change CPU, Memory, and Disk allocations **without container reboot**



Live Migration

Move containers between physical servers with **no service interruptions**

Mass Management
Control your physical and virtual Infrastructure from a **single interface**



OS & Application “Templates”

Deploy Configured OS and Application Stacks En-Masse

- Provision full applications or updates to all or some of your containers

Mix-and-Match Linux Distributions on a Single Server

- Including multiple versions and editions of:
 - CentOS, Debian, Fedora Core, RedHat, SuSe, Ubuntu

Low Overhead, Minimal Initial Footprint

- New containers consume
 - 40MB disk space
 - 10MB memory
- Cache common files for substantial storage cost savings
- Share memory across containers for substantial RAM savings



Managing the Parallels Elastic IT Platform

Create and Destroy Virtual Servers in Seconds

- Quickly create / deploy containers with a few clicks
- Virtual environments are typically up and running within seconds from clicking “Create”

Control Physical & Virtual Servers from One Interface

- Web-based Parallels Virtual Automation, a multi-tenant management portal
- Enables custom integration with existing systems

Quickly Account for All Datacenter Resources

- Track resource usage on a per container basis
- Configure complex resource limitations and traffic shaping rules to match your infrastructure’s needs

Basic Functions

Provision
De-provision
Power On
Power Off
Restart
Backup
Clone
Migrate
Application
 -Deployment
 -Removal
 -Configuration
P2V
Disk / Mem Limits
CPU Resources
File Mgmt
Network Config

Management Tools

Parallels Virtual Automation – Infrastructure

https://98.188.213.77:4648/vz/cp/wnd,2561facb-4200-c144-8cfb-bf7b6d071427

Parallels Virtual Automation – Inf...

Parallels Virtual Automation

Search whole system Virtual Environments

Logged in as **Blake M. Tyra** Sign Out

Screen ID: 10.00.00.01.05

Help Refresh

New... Create Subfolder

Infrastructure

Summary Hardware Nodes Virtual Environments Resources Logs Backups Security

An overview of Hardware Nodes and Virtual Environments in your datacenter. You can click the hyperlinked numbers below to see the corresponding lists of objects or launch common tasks from the Tasks group.

Virtual Environments

Status	Total: 23	OS	Total: 23	Technology	Total: 23
Running	21	Windows	21	Parallels Virtuozzo Containers	23
Stopped	2	Linux	2	Parallels Server Virtual Machines	0

Hardware Nodes

Status	Total: 6	OS	Total: 6	Node Type	Total: 6
Online	6	Windows	3	Parallels Server	0
Offline	0	Linux	3	Parallels Server Bare Metal	1
				Parallels Virtuozzo Containers	5

Overall Status

- All Virtual Environments are operating normally.
- All Hardware Nodes are operating normally.

Tasks

Create In This Folder

- New Subfolder
- New Virtual Environment
- New Hardware Node
- New Backup
- Migrate Server to Container

Manage Infrastructure

- Global Policies
- Management Node

My Tasks (No running tasks at the moment.)

Task Log Refresh My Tasks

Virtual Server Snapshots

Parallels Virtual Automation - Container demo-container

https://98.188.213.77:4648/vz/cp/wnd,2561facb-4200-c144-8cfb-bf7b6d071427

Parallels Virtual Automation - Co...

Parallels Virtual Automation

Search whole system Virtual Environments

Logged in as **Blake M. Tyra** Sign Out

Screen ID: 03.02.01.13.01

Help Refresh Upper Level

New... Configure... Manage... Maintenance... Start Stop Restart Suspend Log In...

Infrastructure > HN vad05-pvclin >

Container demo-container

Summary Network Resources Software Services Logs Backups Security

Information: The Virtual Environments have been scheduled for backing up. (Details)

On this screen you can see a list of available backups for the Virtual Environment. A backup of the Virtual Environment stores all of its data including system and user files. The Power Panel user is allowed to create up to 1 backup(s).

Backed Up from Backed Up to Backup Type Backup Node

Search Reset Results Customize

Backups (3) Per page: 10 | 20 | 40 | 80 Select Columns Hide Search

New Backup Renew Backup Restore Virtual Environment Remove Backups

<input type="checkbox"/>	Backed Up	Backup Node	Size	Description	Backup Type
<input type="checkbox"/>	Feb 19, 2010 10:05:25 AM	vad05-pvclin	90.72 KB		Incremental
<input type="checkbox"/>	Feb 19, 2010 10:04:55 AM	vad05-pvclin	4.70 MB		Full
<input type="checkbox"/>	Feb 19, 2010 10:04:28 AM	vad05-pvclin	4.70 MB		Full

My Tasks (1 task running at the moment.)

Task Log Refresh My Tasks

Minimal Resource Usage

root@demo-container:~ — ssh — 80x24

```
[root@demo-container ~]# df -h
```

Filesystem	Size	Used	Avail	Use%	Mounted on
/dev/vzfs	10G	37M	10G	1%	/
none	512M	4.0K	512M	1%	/dev

```
[root@demo-container ~]# free -m
```

	total	used	free	shared	buffers	cached
Mem:	1024	15	1008	0	0	0
-/+ buffers/cache:		15	1008			
Swap:	0	0	0			

```
[root@demo-container ~]#
```

Granular Resource Controls

Parallels Virtual Automation - Management - Resources

https://98.188.213.77:4648/vz/cp/wnd,2561facb-4200-c144-8cfb-bf7b6d071427

Parallels Virtual Automation - Ma...

Parallels Virtual Automation

Search whole system Virtual Environments

Logged in as [Blake M. Tyra](#) [Sign Out](#)

Manage the Container resources.

▼ CPU Parameters

Parameter	Limited	Current Usage	Soft Limit	Hard Limit	Units	Description
cpuunits	<input checked="" type="checkbox"/>	n/a	n/a	1000	pcs	Guaranteed CPU power
cpulimit	<input checked="" type="checkbox"/>	n/a	n/a	100	percent	Allowed CPU power
burst_cpulimit	<input checked="" type="checkbox"/>	n/a	n/a	100	percent	Container CPU power limit
burst_cpu_avg_usage	<input checked="" type="checkbox"/>	n/a	n/a	100	percent	CPU usage limit
cpus	<input type="checkbox"/>	n/a	n/a	Unlimited	pcs	Number of CPUs

▼ Disk Quota

Parameter	Limited	Current Usage	Soft Limit	Hard Limit	Units	Description
diskspace	<input checked="" type="checkbox"/>	0.04	10	10	GB	Total size of disk space that may be consumed by the Container
diskinodes	<input checked="" type="checkbox"/>	6,917	200000	220000	inodes	Number of disk inodes
quotauidlimit	<input type="checkbox"/>	0	n/a	Disabled	pcs	Number of user/group IDs
quotatime	<input checked="" type="checkbox"/>	n/a	n/a	0	seconds	Grace period of Container disk quota
ioprio	<input checked="" type="checkbox"/>	n/a	n/a	4	units	Container priority for disk I/O operations

▼ Memory Parameters

Parameter	Limited	Current Usage	Soft Limit	Hard Limit	Units	Description
slmmemorylimit	<input checked="" type="checkbox"/>	11.77	1024	1024	MB	SLM memory limit

▼ Primary System Parameters

Parameter	Limited	Current Usage	Soft Limit	Hard Limit	Units	Description
numproc	<input checked="" type="checkbox"/>	n/a	n/a	240	pcs	Number of processes and kernel-level threads
numtcpsock	<input checked="" type="checkbox"/>	n/a	n/a	360	pcs	Number of TCP sockets

My Tasks (No running tasks at the moment.)

[Task Log](#) [Refresh My Tasks](#)

Easy Application Management

Parallels Virtual Automation - Container demo-container

https://98.188.213.77:4648/vz/cp/wnd,2561facb-4200-c144-8cfb-bf7b6d071427

Parallels Virtual Automation - Co...

Parallels Virtual Automation

Search whole system Virtual Environments

Logged in as **Blake M. Tyra** Sign Out

Infrastructure

- vad01-pvcw2k3
 - desk-acct-11998
 - desk-acct-25873
 - desk-acct-28955
 - desk-acct-31368
 - desk-acct-3945
 - desk-it-12372
 - desk-it-15678
 - desk-it-5344
 - desk-legal-23163
 - desk-legal-28709
 - desk-legal-30451
 - desk-sales-14352
 - desk-sales-22059
 - desk-sales-24907
 - desk-sales-26474
 - desk-sales-30057
 - desk-sales-4841
- vad02-pvcw2k3
 - active-directory
 - quest-app-portal
 - quest-broker
- vad03-pvcw2k8
 - killme
- vad04-pvcln
 - pva-mgmt
- vad05-pvcln
 - demo-container
- vad06-pvcln

New... Configure... Manage... Maintenance... Start Stop Restart Suspend Log In...

Infrastructure > HN vad05-pvcln >

Container demo-container

Screen ID: 03.02.01.09.01

Help Refresh Upper Level

Summary Network Resources **Software** Services Logs Backups Security

Applications **Installed Packages** Control Panels

Manage your Container applications working with individual software packages.

Arch Status Name Epoch Version Search Reset Results Customize

Installed Packages 1-20 of 209 << First < Prev Page 1 of 11 Next > Last >> Per page: 10 | 20 | 40 | 80 Select Columns Hide Search

Install New Package Update Update All Uninstall

<input type="checkbox"/>	Name	Epoch	Version	Arch	Summary	Status
<input type="checkbox"/>	apr		1.2.7-11	x86_64	Apache Portable Runtime library	Up-to-date
<input type="checkbox"/>	apr-util		1.2.7-7.el5	x86_64	Apache Portable Runtime Utility library	Up-to-date
<input type="checkbox"/>	aspell	12	0.60.3-7.1	i386	A spelling checker.	Up-to-date
<input type="checkbox"/>	aspell	12	0.60.3-7.1	x86_64	A spelling checker.	Up-to-date
<input type="checkbox"/>	aspell-en	50	6.0-2.1	x86_64	English dictionaries for Aspell.	Up-to-date
<input type="checkbox"/>	audit-libs		1.7.7-6.el5	x86_64	Dynamic library for libaudit	Up-to-date
<input type="checkbox"/>	audit-libs-python		1.7.7-6.el5	x86_64	Python bindings for libaudit	Up-to-date
<input type="checkbox"/>	authconfig		5.3.21-5.el5	x86_64	Command line tool for setting up authentication from network services	Up-to-date
<input type="checkbox"/>	basesystem		8.0-5.1.1	noarch	The skeleton package which defines a simple Red Hat Linux system.	Up-to-date
<input type="checkbox"/>	bash		3.2-24.el5	x86_64	The GNU Bourne Again shell (bash) version 3.2	Up-to-date
<input type="checkbox"/>	bind	30	9.3.4-10.P1.el5	x86_64	The Berkeley Internet Name Domain (BIND) DNS (Domain Name System) server.	Up-to-date
<input type="checkbox"/>	bind-libs	30	9.3.4-10.P1.el5	x86_64	Libraries used by the BIND DNS packages	Up-to-date
<input type="checkbox"/>	bind-utils	30	9.3.4-10.P1.el5	x86_64	Utilities for querying DNS name servers.	Up-to-date
<input type="checkbox"/>	binutils		2.17.50.0.6-9.el5	x86_64	A GNU collection of binary utilities.	Up-to-date
<input type="checkbox"/>	binutils		2.17.50.0.6-9.el5	x86_64	A GNU collection of binary utilities.	Up-to-date

My Tasks (No running tasks at the moment.) Task Log Refresh My Tasks

Linux Workloads: Challenge

- Many Linux applications are single threaded (do not scale up)
- Deployed on many 2P X86/X64 servers (forced scale out)
 - Do not leverage multi-core CPU capabilities
- Cannot co-exist with other applications (require isolation)
- Results in under-utilized compute resources (typically running at ~20% load per 2P server)

Solution: Parallels Containers for Linux

- **Customize functionality and implementation with existing systems by integrating with a fully documented XML-RPC API**
 - As flexible as an infrastructure foundation should be
- **Run a minimum of 3x more virtual environments per server as compared to hypervisors.**
 - ✓ Save on hardware, datacenter space, power consumption & administration requirements.
- **Maintain time clock consistency by using the host clock preventing the “time fade” experienced by hypervisors.**
 - ✓ Rely on the accuracy of the timestamps within applications.
- **Directly access hardware for I/O including networking & disk access to improve response times far better than going through the virtual machine manager of a hypervisor.**
 - ✓ Eliminate bottlenecks and virtualize more applications than you thought possible.

Linux Workload Performance Benchmarks

- **Measurement process**

- simple bash script for all running CTs/VMs
 - `time ssh root@ct101 "cd /root/kernel; make -j 4"&`
- Copy Linux 2.6.18 kernel source to each Parallels Container/Xen VM
- Perform kernel compilation in for varying numbers of CTs/VMs:
 - `make clean; yes "" make config; make -j 4`
 - `-j` reflects number of CPUs available
- Collect total compilation time for all compiles and determine average

- **Average “kernels per minute”**

- This metric is more suitable than kernel compilation time as you can compare performance of, for example, 4 and 8 VMs in terms of “how many kernels they can compile within a specific timeframe”.

Hardware / Software

Hardware

CPU	Memory	Storage
Dual CPU / Quad Core Intel Xeon 3.0 GHz	32 GB RAM (16x2), 667 MHz	4xSAS 15K RPM Symbios Logic MegaRAID SAS 1078

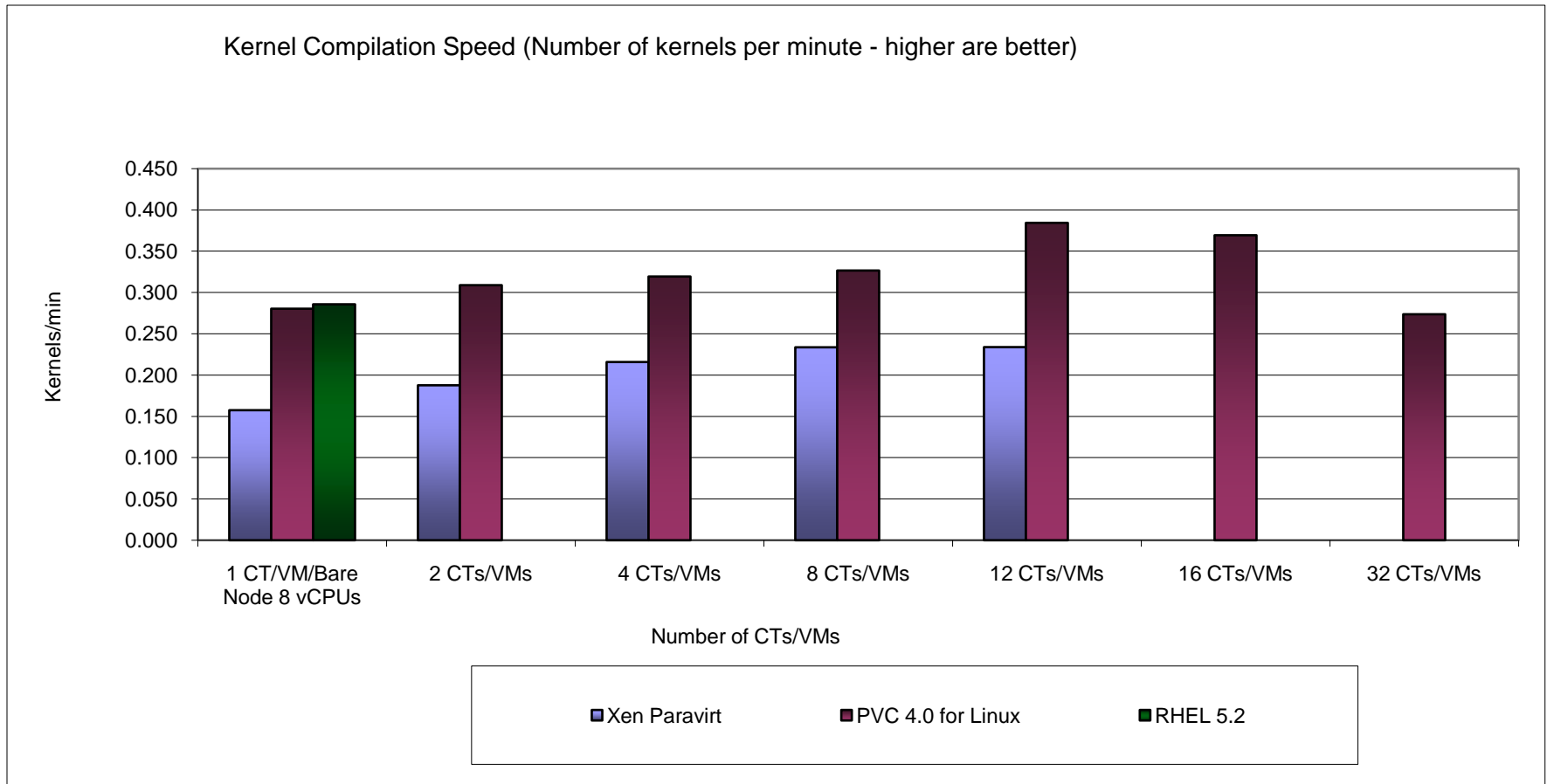
Software

Host OS	Guest OS	Containers/VM config
RHEL 5.2 (x64) Xen (xen.gz-2.6.18-8.el5)	RHEL 5.2 (Para-virtualization enabled)	4 Virtual CPUs, 4 GB RAM (pre-allocated disk in file)
RHEL 5.2 (x64) Parallels 4.0 (x64)	RHEL 5.2	4 Virtual CPUs, 4 GB RAM (Parallels Containers does not require a virtual disk)

Performance Notes

- **Parallels Containers/Xen performance “kernel per minute” can be better than native node numbers due to better compilation scalability in CTs/VMs**
- **Could not run tests for 16 Xen VMs due to memory limitations in Xen**
 - Parallels Containers could compile in parallel in both 16 & 32 containers
 - Parallels Containers compile performance decrease minimally as CT count grows
 - Xen is not stable at high VM numbers
 - We limited testing to 32 CTs/VMs due to Qualcomm density recommendations
- **Compilation time in containers shows average than 5-10% difference**
 - Compilation process not only starts at the same time in all containers, but also finishes at approximately the same time.
 - In this case kernel compilation speed (kernel per minute) can be evaluated as $\text{number_of_CTs} \times 1 / \text{average_compile_time} = 3 \times 1 / 7 = 0,42$ very close to calculated 0,43
- **Compilation performance variance depends on many factors**
 - i.e. disk bottleneck (slow hardware storage), increases disk access....

Benchmark Results



Parallels Containers achieved 40-78% better performance

Benchmark Results

Average kernel compilation time
in each CT/VM

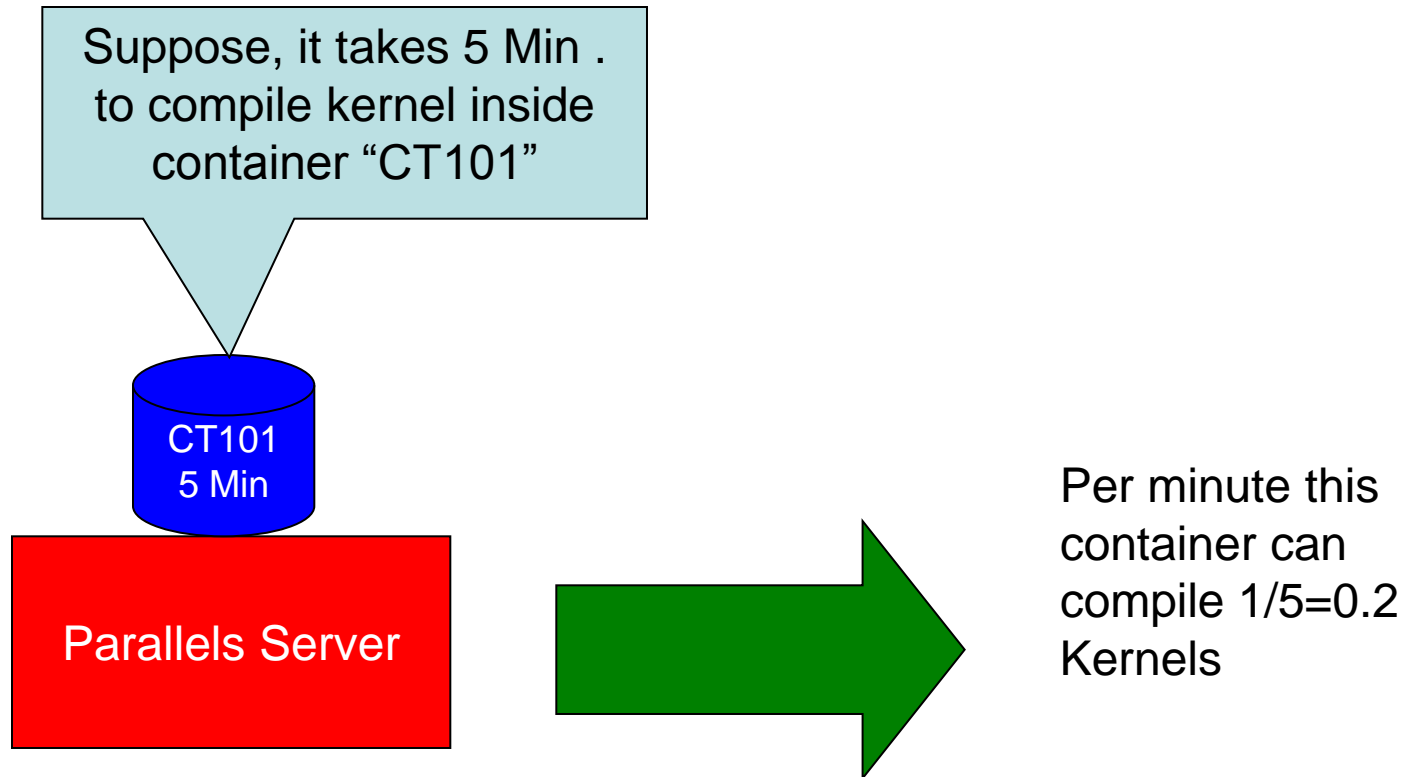
Average number of kernels per minute
that can be compiled in parallel
($\text{number_of_VMs} \times 60 / (\text{average_kernel_compile_time_in_seconds})$)

Percentage Parallels is faster
at compiling a kernel under
load vs. Xen Para-virtualization

CT / VM Count	Kernel Compilation (sec)			Compilation (kernels/min)			Parallels Performance Benefit
	Parallels	Xen Paravirt	RHEL 5.2	Parallels	Xen Paravirt	RHEL 5.2	
Bare Node			210			0.286	
1	214	381		0.280	0.157		78%
2	389	640		0.309	0.188		65%
4	752	1,112		0.319	0.216		48%
8	1,470	2,054		0.327	0.234		40%
12	1,873	3,079		0.384	0.234		64%
16	2,599	n/a		0.369	n/a		
32	7,016	n/a		0.274	n/a		

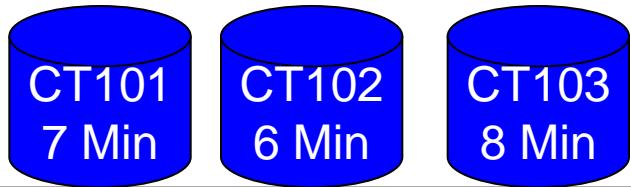
Parallels Containers achieved 40-78% better performance

Average number of kernels per minute



Average number of kernels per minute

Suppose, it takes 7 Min . to compile kernel inside container “CT101”, 6 Min to compile kernel in “CT102” and 8 Min to compile kernel inside “CT 103”. The compilation was started at the same time in all containers.



Parallels Server

So, “CT 101” compiles $1/7$ kernels per minute, “CT 102” $1/6$ kernels per minute and “CT 103” $1/8$ kernels per minute. And they do this compilation at the same time! **Total server** compilation speed: $1/7 + 1/6 + 1/8 \sim 0.43$ it's >two times faster than when we use 1 CT (0,2 kernels per minute on the previous slide).

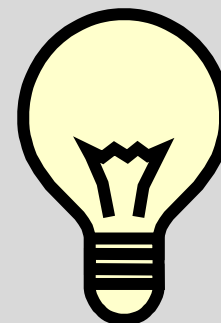
Parallels Containers Scalability on Linux – Results

- **Unique OS Virtualization approach enables neutral to positive throughput when compared bare OS baseline results across a range Linux applications**
 - Assigning one Container to each CPU Core yields the maximum results
 - For environments which need to support higher isolated workload, Parallels Containers yields solid results at two Containers per Core
- **Parallels Containers scale to enable maximum utilization on server hardware while providing complete workload isolation**
 - No limitation of resource allocation per Container → Scale up or Scale out

Summary of Parallels Elastic IT Platform

Enterprise Can Save Millions!!!

- Consolidating Servers through **Virtualization**
 - *Eliminate Underutilization*
 - *Reduce Needed Datacenter Space*
 - *Reduce Energy Costs*
 - *Reduce Storage Costs*
 - *Reduce Software Licensing Costs*
- Mass Manage through **Automation**
 - *Optimize Capacity Planning*
 - *Dynamically Allocate Resources*
 - *Quickly Mass Deploy Applications*



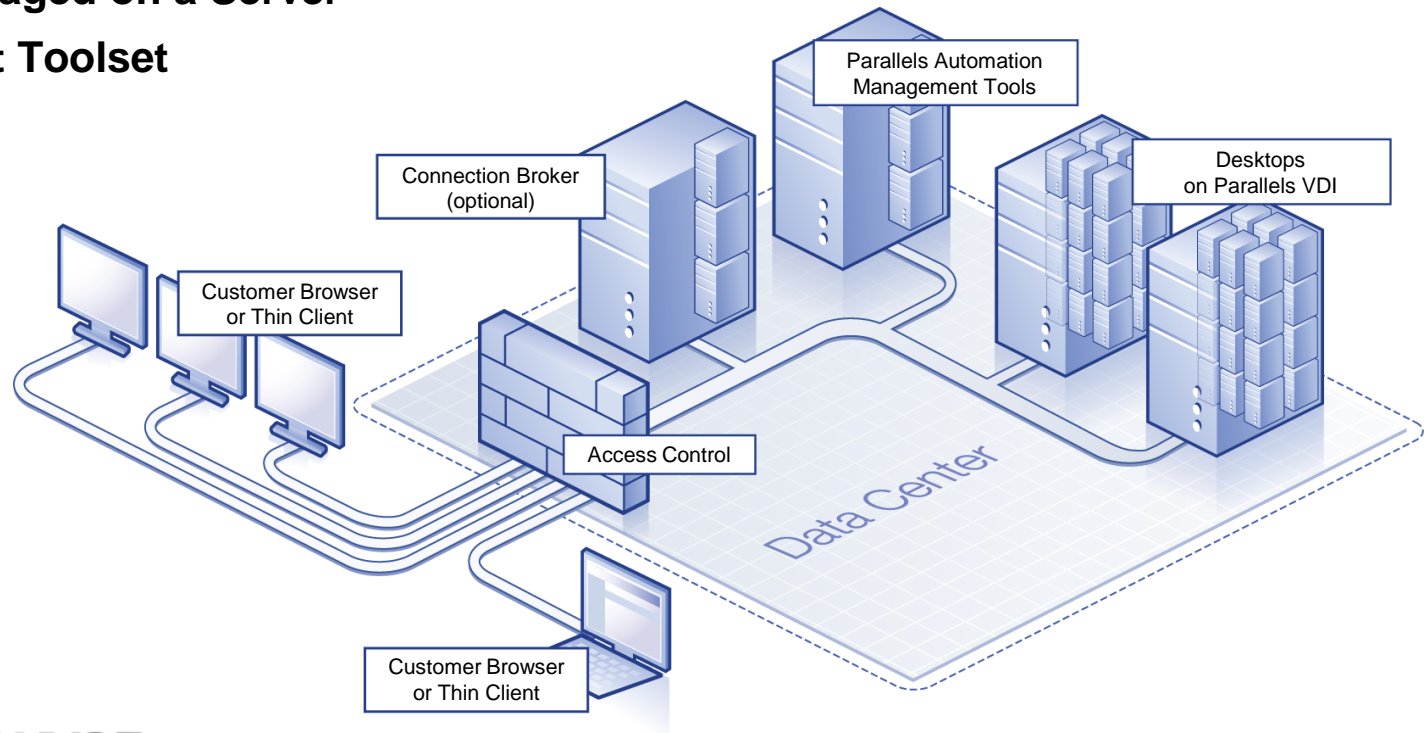
Over the next 5 years, most enterprise data centers will spend as much on energy (power and cooling) as they do on hardware infrastructure.

Gartner[®]

Gartner, Inc. "Eight Critical Forces Shape Enterprise Data Center Strategies"

Parallels VDI: A Complete End-to-End Solution

- The **Most** cost-effective solution to deliver server-based desktops.
- Thin Client/Desktop & Connection Broker
 - Familiar and Flexible End User Experience
- Desktops Imaged on a Server
- Management Toolset



Parallels VDI Solves Desktop Challenges

Reduce Operating Costs

Total cost of ownership reduced 70% over standalone PC environments

Minimizing Security Risk / Meeting Compliance Guidelines

Data centrally stored ensures security, control and reliability. Parallels VDI only solution including backup tools

Improved Manageability Reduce Support Requirements

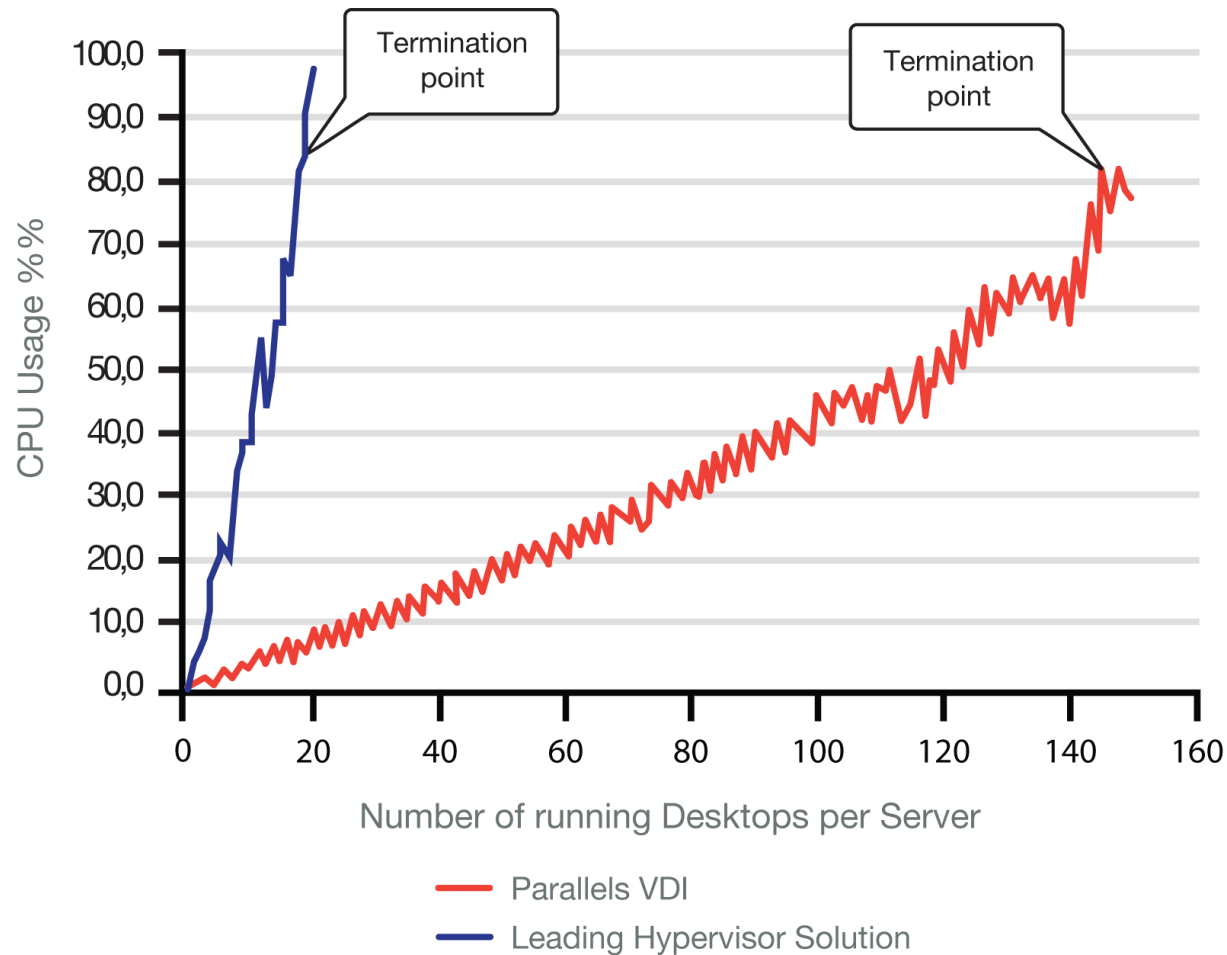
Provision desktops, add/update applications, users, groups in seconds , eliminate end-user request visits. increase administrative efficiencies 70%

Maximization of System Utilization

Consolidation ratios 3 times higher than hypervisors results in 100's of desktops per server significantly reducing energy consumed and support costs.

Gartner estimates about 50 million desktop users will be on VDI by 2013.

Parallels VDI: 7 X Desktops versus leading Hypervisor



Superior Desktop-Server Consolidation

Ratio: Up to 140 vs. ~20 Desktop Images

Tests run on a DL380/G5 (www.parallels.com/solution/vdi)

The background of the slide features three computer monitors. The central monitor is in sharp focus, while the two flanking monitors are blurred. Each monitor's screen displays a white, stylized cloud graphic. The text "Q & A" is centered within the cloud on the central monitor.

Q & A